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DOCUMENT-IDENTIFIER: US 6348908 B1
TITLE: Ambient energy powered display

Brief Summary Text (2):
The following patents and patent applications are herein incorporated by reference: U.S. Pat. No. 4,126,854 to Sheridon; U.S. Pat. No. 4,143,103 to Sheridon; U.S. Pat. No. 5,604,027 to Sheridon; pending U.S. Pat. application Ser. No. 08/960,865 entitles "TWISTING CYLINDER DISPLAY" filed Oct. 30, 1997; and pending U.S. Pat. application Ser. No. 08/960,868 entitled "A TWISTING CYLINDER DISPLAY USING MULTIPLE CHROMATIC VALUES" filed Oct. 30, 1997; U.S. Pat. application Ser. No. 08/713,935, entitled "MONOLAYER GYRICON DISPLAY"; U.S. Pat. application Ser. No. 08/713,936, entitled "HIGH REFLECTANCE CYRICON DISPLAY"; U.S. Pat. application Ser. No. 08/716,675, entitled "GYRICON DISPLAY WITH INTERSTITIALLY PACKED PARTICLE ARRAYS"; and U.S. Pat. application Ser. No. 08/713,325, entitled "GYRICON DISPLAY WITH NO ELASTOMER SUBSTRATE".

Brief Summary Text (5):
The invention relates to visual displays. More particularly, the invention relates to reusable, paper-like, gyricon or twisting-particle type or other bistable visual displays and apparatus for driving displays.

Brief Summary Text (10):
A gyricon display, also called a twisting-element display, rotary element display, particle display, dipolar particle light valve, etc., offers an example of a technology for making a form of electric paper. Briefly, a gyricon display is an addressable display made up of a multiplicity of optically anisotropic particles, such as, for example, spheres, each of which can be selectively rotated to present a desired image to an observer. For example, a gyricon display can incorporate rotational elements each having two distinct halves, e.g., one half may be black, while the other half is white.

Brief Summary Text (12):
The electric field is applied to the sheet by an external power source that is coupled across electrodes within the sheet. The polarity of the applied electric field dictates which portion of the elements is viewable to an observer. For example, a positive electric field may cause the elements to rotate such that block portions of the elements are visible, whereas a negative electric field may cause the elements to rotate so that white portions of the elements are visible. Thus, an electric field that is applied with alternating polarities can result in a switching or flashing display. However, the known gyricon displays cannot switch without the external power supply coupled across the electrical conductors within the sheet.

Brief Summary Text (15):
In another aspect of the invention, the display is switchable display that is both powered by and viewable in ambient energy, e.g., visible light. The switchable display oscillates or alternates the presentation of the display. For example, the display is switched from a black-on-white display to a white-on-black display.

Drawing Description Text (3):
FIG. 1 is a perspective, exploded view of a conventional gyricon display;

Detailed Description Text (2):
Typically, known gyricon displays are made up of various types of rotating particles of elements. For example, U.S. Pat. No. 4,126,854 to Sheridon, which is incorporated by reference hereinabove, at FIGS. 1-3 depicts an example of a twisting element panel display.

Detailed Description Text (3):
Looking at FIG. 1, a display 10 has a display panel 14 sandwiched between substrates 16 and 18. Intermediate the display panel 14 and substrate 16 is a first grid 11. Although not shown in FIGS. 1 and 2, the first grid 11 may include a single continuous conductive layer, one or a plurality of patterned electrical conductors, or a matrix of selectively addressable electrical conductors. FIGS. 1 and 2 show a second grid 12 having electrical conductors 12' provided between the substrate 18 and the display panel 14. Like the first grid 11, the second grid 12 may also comprise a single continuous conductive layer, one or a plurality of patterned electrical conductors, or a matrix of selectively addressable electrical conductors.

Detailed Description Text (4):
As shown in FIG. 2, at least one of the substrates 16 and 18 and at least one of the electrical conductors or conductive layer of the grid 11 or 12 adjacent the substrate 16 or 18 are optically transparent so that the display provided by the panel 14 can be viewed. In FIG. 2, the substrate 16 and grid 11 are made of optically transparent materials so that light incident upon the display panel 14 is reflected/absorbed to provide a visible image at I.

Detailed Description Text (11):
FIG. 4 illustrates a sectional view of a display 400 in accordance with the invention. It can be seen that the display 400 is similar to the display 10 in FIGS. 1-2 except that the external power source 29 is replaced by a controller C and an ambient energy receiver 420. The controller C is powered by electrical power provided by the receiver 420 so that the controller C can apply driving signals to the display 400. It should be noted that the gyricon display 400 depicted in FIG. 4 is merely for explanatory purposes and that it should be apparent that any bistable display can be used. It should also be noted that the ambient energy receiver 420 and the controller C can be built into the display 400, for example, by placing the receiver 420 and controller C into a semi-rigid frame that can hold the receiver 420 and controller C together with the display 400. The receiver 420 and controller C are depicted as being attached on the side in FIG. 4 to simplify the explanation of the invention.

Detailed Description Text (12):
Ambient energy AE is the energy surrounding the display 400 in the environment in which the display 400 is located. For example, if the display 400 is located in an office, the ambient energy AE can be the energy that illuminates the office, such as, for example, sunlight, fluorescent light, incandescent lamps, candlepower, oil lamps and any other form of illumination that will provide light in the visible region. However, ambient energy AE is not limited to light in the visible portion of the spectrum.

Detailed Description Text (13):
Ambient energy AE can also be non-visible energy such as, for example, infrared light or the infrared portion of the spectrum. Additionally, ambient energy AE is not limited to light, either visible or non-visible, but can also include such forms of energy or energy sources as electromagnetic radiation, sound, electromagnetic fields, temperature, humidity, pressure, mechanical vibration or displacement, or any other measurable form of energy that can be collected an converted into electrical energy to provide the necessary driving signals for applying an electric filed to the display 400.

Detailed Description Text (14):
In other words, the display 400 is a stand alone display 400 that requires no external power source or electronics attached to the display 400 to provide the driving signals needed for application of the electric field necessary to show the image to be observed. In the disclosed embodiment, the display panel 414 is a gyricon display, but can be any one of many different kinds of displays, as discussed below.

Detailed Description Text (15):
The display panel 414 is sandwiched between the substrates 416 and 418. Intermediate the display panel 414 and substrate 416 is a first grid 411. As discussed above with regard to the display 10 in FIGS. 1-3, although the first grid 411 is illustrated as a continuous conductive layer, the grid 411 may also include patterned electrical conductors (not shown) and/or a matrix of selectively addressable electrical conductors (also not shown) if such displays are desired. Again, although FIG. 4 depicts a second grid 412 having first and second electrical conductors 412' and 412", respectively, the second grid 412 can also be comprised of a continuous conductive layer (not shown) and/or a matrix of selectively addressable electrical conductors (not shown). The second grid 412 is provided between the substrate 418 and the display panel 414.

Detailed Description Text (16):
At least one of the substrates 416 and 418 and the electrical conductors of the grid adjacent the substrate are optically transparent so that light is incident on the display panel 414 and so that the image provided by the display panel 414 can be viewed. Substrate 416 and grid 411 are made of optically transparent materials so that the light incident upon the display 400 will provide a visible image at I.

Detailed Description Text (36):
For example, it is envisioned that the display according to the invention be used for visible or invisible light powered warning signs, such as the display illustrated in FIG. 6 to alert diners in a cafeteria that smoking is prohibited. In another example of the display according to the invention, it is envisioned that the display is wrapped around power lines. As such, if the power lines are active, an electric field is applied to the display, which shows an image that reads, for example, ON or DANGER. Consequently, when a repairman is called to service a line, the repairman can visually determine if the line is active and take the necessary precautions. In yet another example of an envisioned application of the display according to the invention, a display can be placed on a power transformer with the ambient energy receiver gathering ambient energy in the form of a magnetic field and show a warning image similar to the power line example discussed above. Other examples are serially addressed free-power scoreboards, on-package advertising, railroad station or airport gate destination signs, a clock or a thermometer, as well as a host of other such suitable applications. As such, the above discussed examples are not intended in any way to limit the scope of the present application, but are merely presented to illustrate the broad-based applications of the display according to the invention.

Detailed Description Text (54):
FIG. 12 illustrates yet another embodiment of the display according to the invention. The display 1200 is similar to the display 400 shown in FIG. 4. However, the grid 412, conductors 412' and 412" and substrate 418 are replaced by a thin plastic layer 1250 and fixed addressing pattern electrodes 1270. The remaining elements of the display 1200 are identical to the elements of the elements of the display 400 and will not be discussed in great detail herein. It should be noted that although the display 1200 is illustrated as having an ambient energy receiver 1220 providing an operating signal to the controller C, a power source (not shown), such as, for example, batteries, hardwire electrical connections or other known or subsequently developed power source, could be used to operate this embodiment of the invention.

Detailed Description Text (56):
For example, a user can select copper peel-of portions for the electrodes 1270 portions to form words or images of a sign, such as, for example, to spell out the words NO SMOKING as illustrated in FIG. 6. The selected letters are applied to the thin plastic sheet 1250 by an adhesive or other such known or subsequently developed adhesion method. In this example and as previously discussed, the substrate 1216 and grid 1211 should be optically transparent. Depending upon the polarity of the applied switching voltages, which are discussed above, the resulting display 1200 can have a constant background color and a worded or symbolic message that alternates between the background with white foreground would alternate to an all black display. Alternatively, the background can be made to switch by construction of suitable electrodes and connection to suitable drive electronics as described above.

Detailed Description Text (57):

In yet another embodiment of the display 1200 according to the invention, a printer capable of printing conductive patterns using a conductive fluid produces a desired pattern on a substrate to be attached to the plastics sheet 1250 of the display 1200 or prints the pattern directly onto the plastic sheet 1250. As such, it is envisioned that the a road crew worker would be able to create a sign that would be placed on the side of the road to arm motorists of an accident further down the road and advising them to plan their route accordingly. An electrode can be fixed within the display to which the foil letters are connected by conductive lines to provides the electric field across the portions of the display covered by the letters.

Detailed Description Text (63):
FIG. 15 illustrates how the bichromal cylinders can be arranged in an elastomer substrate of a display 1530. In the display 1530, the bichromal cylinders 1531 are disposed in an elastomer substrate 1532 that is swelled by a dielectric fluid in the cavities 1533 in which the cylinders 1531 are free to rotate about their respective longitudinal axes. Cavities 1533 are not much longer in diameter than cylinder 1531, so that cylinders 1531 are constrained from rotating about their medial axes. Cylinders 1531 are electrically dipolar in the presence of the dielectric fluid, and so are subject to rotation upon application of an electric field. As shown, cylinders 1531 can be rotated so as to expose either their white or black faces to an observer at I.

Detailed Description Text (69):
FIG. 18 shows a rotating particle 1815 surrounded by an oil 1814. A separate encapsulating shell 1820 encloses both the rotating particle 1815 and the oil 1814 to allow for the free rotation of the rotating particle 1815. The rotating particle 1815, the oil 1814 and the encapsulating shell 1820 are encased in a substrate 1816. A wide variety of substrate materials are possible due to the use of encapsulated rotating elements which eliminates the need to swell the substrate 1816 in a elastomer.

Detailed Description Text (70):
To ensure the optimum level of color saturation and overall image quality in a display, a layer of rotating elements should appear as complete to an observer as possible. Several methods are known in the art for obtaining optimum area coverage. For example, the packing methods described in U.S. Pat. application Ser. No. 08/713,935, entitled "MONOLAYER GYRICON DISPLAY"; U.S. Pat. application Ser. No. 08/713,936, entitled "HIGH REFLECTANCE GYRICON DISPLAY"; U.S. Pat. application Ser. No. 08/716,675, entitled "GYRICON DISPLAY WITH INTERSTITIALLY PACKED PARTICLE ARRAYS"; and U.S. Pat. application Ser. No. 08/713,325, entitled "GYRICON DISPLAY WITH NO ELASTOMER SUBSTRATE" and herein incorporated by reference can be applied to the display of this invention.

Other Reference Publication (1):
N. K. Sheridon et al., "The Gyricon--A Twisting Ball Display," Proceedings of the SID, US, Society for Information Display, Playa Del Rey, CA, vol. 18, No. 3&4, Jan. 1, 1977, pp. 289-293.

Other Reference Publication (4):
N.K. Sheridon and M.A. Berkovitz, "The Gyricon--A Twisting Ball Display", Proceedings of the S.I.D., vol. 18/3 & 4, 1977, pp. 289-293.

CLAIMS:

3. The ambient energy powered display according to claim 2 wherein the bitable display device comprises a gyricon display.

16. The bistable display according to claim 14 wherein the bistable display device comprises a gyricon display.